You...

and the DEPARTMENT OF MINES AND TECHNICAL SURVEYS

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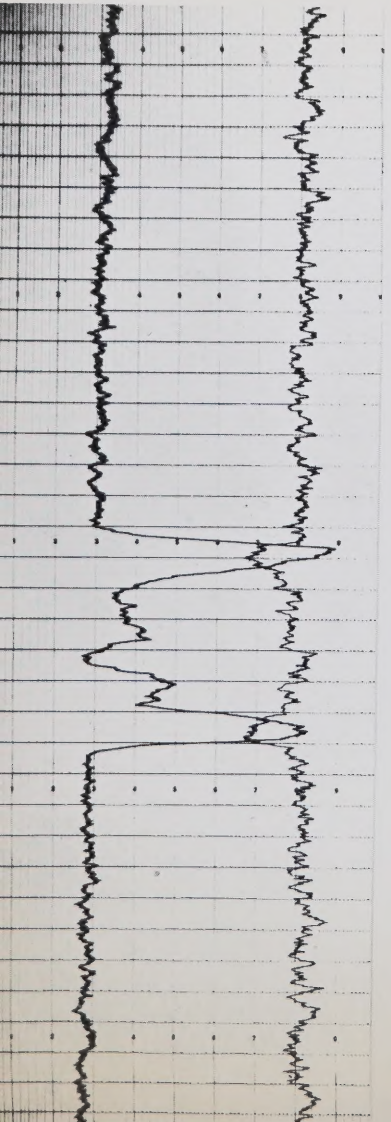

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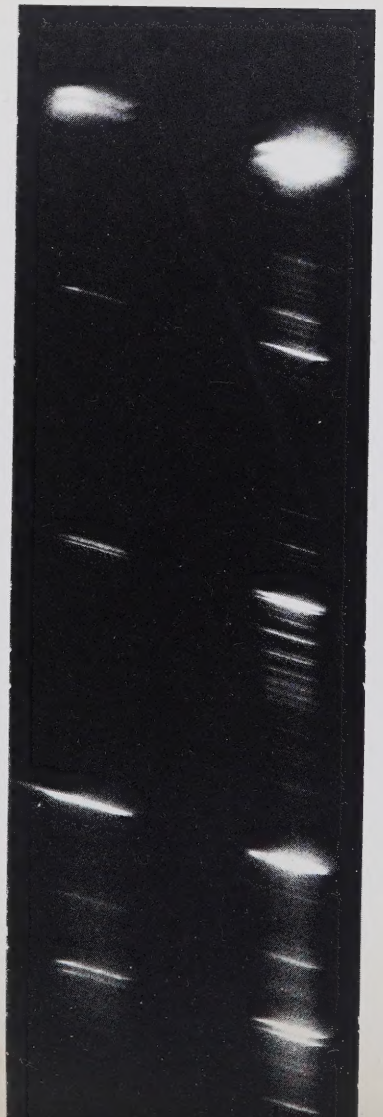

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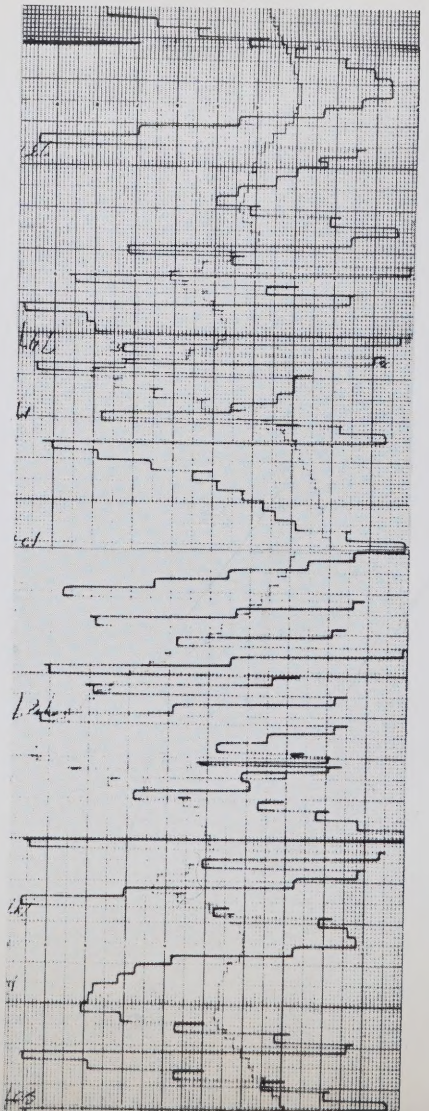

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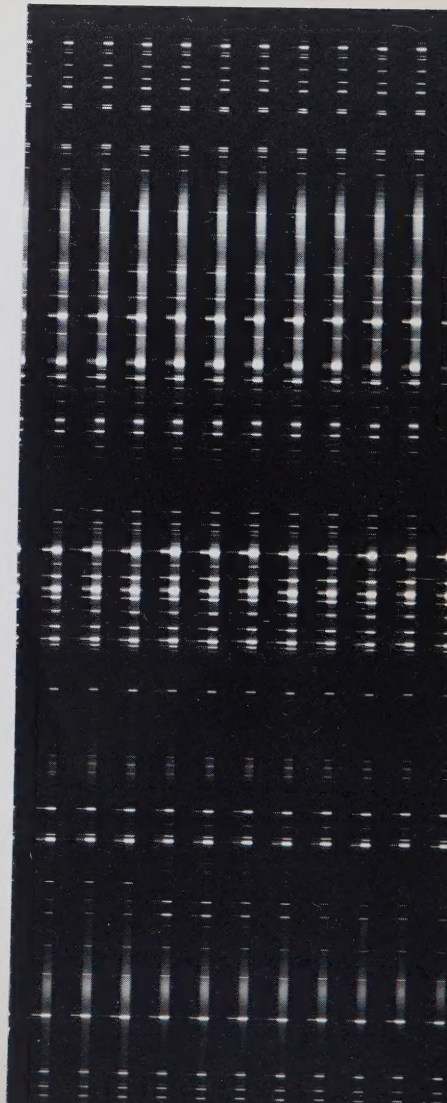

You...

and the DEPARTMENT OF MINES AND TECHNICAL SURVEYS

Cover photo –

Building complex housing the Department of Mines and Technical Surveys (centre) is situated near Ottawa's picturesque Dow's Lake. Parliament Hill, with the Peace Tower, is in the right background.

(courtesy A. F. Lambert)

ROGER DUHAMEL, F.R.S.C.
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YOU....

... and the Department of

MINES AND TECHNICAL SURVEYS

This is your introduction to the Department of Mines and Technical Surveys. This booklet tries to fit together the jigsaw puzzle of the many skills and professions that make up the staff of the Department — the oldest government research organization in Canada, and one of the largest and most diversified. Whatever your role, actual or potential, in the Department, you will have a share in a great adventure of scientific research and exploration.

Before describing the work of the various units making up the Department of Mines and Technical Surveys, we ought to answer a few basic questions.

WHAT IS IT?

The Department of Mines and Technical Surveys is a branch of the Federal Government. It is headed by a cabinet minister and administered by a deputy minister. The staff of the Department, which comes from every province and from almost every profession in Canada, is hired through the Civil Service Commission and is employed under the Civil Service Act.

WHAT IS ITS PURPOSE?

The Department is primarily a scientific and technical organization. Briefly, its purpose is to survey and map the land and water areas of Canada, to chart, assess, and aid in the processing of its mineral resources, to carry out astronomical, geophysical, and geographical studies, and to undertake certain administrative and information work connected with resource development. Insofar as comparisons are valid, the Department's functions resemble in some respects those of the National Research Council, in others those of the Bureau of Statistics, in still others those of the Department of Agriculture (except that the resources it deals with are mineral rather than biological).

WHERE IS IT?

Most of the Department's offices and laboratories are in the Ottawa area, and are concentrated in a relatively new group of buildings along Booth Street off Carling Avenue. The Department does, however, maintain several important installations in other parts of Canada. Chief among these are the Bedford Institute of Oceanography near Halifax, the Astrophysical Observatory at Victoria, and the Radio Astrophysical Observatory at Penticton. There are also small geological, marine, and survey offices in some cities, and several scientific observation posts in our Arctic and sub-Arctic regions.

WHERE IS THE WORK?

Of the Department's staff of 2,870 in early 1963, only 340, or 12%, worked permanently in locations other than Ottawa. There is, however, a large *temporary* movement of staff all across Canada each year. This is the annual summer migration of survey and research parties from Ottawa into the field. A good share of this migration is directed northward. These hundreds of scientists and technicians are augmented by temporary, non-civil service staff. Some of these temporary employees are themselves scientists, others are laborers, still others are seamen. Most field work ceases during winter, but a few parties and observation posts work the year round.

WHO ARE THE WORKERS?

The Department of Mines and Technical Surveys embodies almost every science and branch of technology, from palaeontology to biogeochemistry, from electronic computers to neutron generators, and provides ample scope for numerous professions. It is not surprising that the staff should contain an unusually high proportion of skilled technical and professional employees, and for many research

positions a Ph.D. is desirable. Laboratory and survey work generally demands persons with special formal training gained before joining the Department. The proportion of administrative and clerical staff is naturally a good deal smaller than in government departments engaged in direct service to the public. The Department does, of course, have its own administrative units, in which all standard office occupations are represented.

HOW IS IT ORGANIZED?

The Department is subdivided functionally; that is, people pursuing the same or similar research or surveys are grouped together as much as practical, no matter where their work may take them. Anyone familiar with the state of modern science and technology will appreciate that such groupings can be neither rigid nor permanent, since it is often difficult to predict the fate of specific projects, or the need for inter-disciplinary cooperation on various projects. At this writing, the Department has six Branches and several smaller units. The Branches are: Surveys and Mapping Branch, Marine Sciences Branch, Geological Survey of Canada, Dominion Observatories, Geographical Branch, and Mines Branch. The other research units are the Mineral Resources Division, the Polar Continental Shelf Project, and the Explosives Division. To provide the administrative and other ancillary services to the research groups, the Department has a Directorate of Personnel, a Directorate of Administration, and an Editorial and Information Division.

HOW DOES IT FUNCTION?

The Geological Survey, the Surveys and Mapping Branch, the Marine Sciences Branch, the Geographical Branch, the Dominion Observatories, and the Polar Continental Shelf Project are "field" units — that is, they obtain the raw material for their studies or their maps directly from nature. The Mines Branch obtains most of its information from tests and experiments in plants and laboratories, and observation at work sites. The Mineral Resources Division and the Explosives Division do not carry out laboratory research of their own but compile analytical reports and make administrative decisions based on data collected on field trips and from other scientific and commercial bodies.

The ancillary units mentioned under the preceding heading will not be described further in this booklet. The duties and qualifications of the personnel staffing them are similar to those in other administrative and publicity work, but they do require special awareness of scientific method, and of the needs of engineers and scientists engaged therein.

Surveys and Mapping Branch

Tellurometer set up at survey station on pressure ridge on sea ice, Prince Gustaf Adolf Sea.

The job of this Branch is to take the measure of Canada's land areas and to publish the results in the form of maps and mathematical tables.

One of the Branch's divisions is the Geodetic Survey of Canada. Among land surveyors and map makers, geodesists are the men with the seven-league boots. Their measurements span enormous distances. They do not concern themselves with the earth's surface as such but with points on the surface. By setting up a control system, a network of points whose position and elevation are accurately determined, the Geodetic Survey provides other surveying agencies with a firm footing for their more detailed work.

Horizontal control is established by triangulation, trilateration, traverse, and astronomic methods. Of these, triangulation, or a network of interlocking triangles, is the most accurate, but it is also slower and more laborious than other methods. Vertical control is achieved by precise levelling, based on mean sea level, with elaborate corrections and precautions.

Fleshing out the skeleton of horizontal and vertical control points provided by the Geodetic Survey is the Topographical Survey, another division of the Surveys and Mapping Branch. Air photography is an important aid in topographical mapping, and in the rugged and often impassable terrain of the Arctic it is a prerequisite. Features revealed by air photographs are plotted by photogrammetry and tied in with control positions set up by the Geodetic Survey and by Topographical Survey field parties.

The Topographical Survey hopes to complete the mapping of Canada at a scale of 1:250,000, or a little less than four miles to the inch, around 1970. In the meantime, more detailed mapping at a scale of 1:50,000 is also proceeding. Civil defence planning demands still larger scales, and greater detail. In addition, the division undertakes numerous special mapping tasks.

Taking mapping another step further in the reproduction of detail is the Legal Surveys and Aeronautical Charts Division. As far as legal surveys are concerned, this unit performs on Federal Government lands the same type of work that private surveyors do for municipalities and subdividers. Much of this work is done at settlements in the Yukon and Northwest Territories, in national parks, and on Indian reserves. Also, the division surveys and marks the boundaries between provinces and electoral districts. Aeronautical charts, though grouped administratively with legal surveys, are an entirely different matter. They are designed for the guidance of aircraft pilots and point out the exact type and location of airfields, flight corridors, electronic signals, etc. These charts are supplemented by flight manuals.

A highly specialized unit operating within the Surveys and Mapping Branch is the International Boundary Commission. This small agency, which has a counterpart in the United States federal government, deals with the surveying, demarcation, and maintenance of the 5,526-mile-long Canada-U.S. boundary.

The "field" divisions of the Branch do not themselves take their map making beyond the "manuscript" or rough draft stage. The final drafting and printing of all maps is done in the Map Compilation and Reproduction Division. This publishing unit carries out its tasks with an advanced and complicated array of drafting instruments and printing presses, and produces each year close to ten million copies of several thousand different maps and charts in many colors. Its total stock of maps and charts in 1962 exceeded 10 million. The division also distributes the maps produced by the Surveys and Mapping Branch to the public through sales offices in Ottawa and other cities.

In addition to its stock of maps, the Branch also maintains a complete set of air photographs of Canada in the National Air Photo Library. These photographs, covering nearly the entire country, now number about 2½ million. Copies of the photographs are sold to many public and private agencies.

The normal academic requirement for a career in the Surveys and Mapping Branch is a university degree in mathematics, physics, or civil engineering; however, some jobs are open to holders of provincial land surveyor's certificates.

Marine Sciences

The Marine Sciences Branch is the youngest of the Department's large research units, although some of its components can look back on a long and proud history.

The Branch was formed in 1962 by combining the new Division of Oceanographic Research with the older Canadian Hydrographic Service, which had previously

The Bedford Institute of Oceanography at Dartmouth, N.S., was officially opened in the fall of 1962. It provides offices and laboratories as well as shops and deep-sea docks for a wide range of maritime research.

been part of the Surveys and Mapping Branch. Both units are concerned with the exploration of the sea surrounding Canada and of Canadian inland waters, and in some respects their work coincides.

Broadly speaking, oceanography is concerned with the sea's physical and chemical characteristics. Such a study would not be complete without taking into account marine biology, submarine geology, and the interaction of sea and weather.

The complicated chemical structure of sea water is especially interesting to oceanographers, both in respect of organic and inorganic compounds and the interaction between them. The distribution of natural and artificial radioactivity, the distribution of heat and density of layers of ocean water, the strength and variation of ocean currents throughout the entire depth of the ocean, underwater acoustics, the stress of wind on sea surface — all these are receiving close attention from the Department's oceanographers, most of whom are based at the Bedford Institute of Oceanography near Halifax.

The findings of oceanographic research are valued and used by many other sciences and practical pursuits: fisheries research, submarine warfare technology, meteorology, harbor construction and other types of seaside engineering, geology, and, of course, navigation. Many of the techniques used by oceanographers are still in their infancy, and this relatively young field offers exciting opportunities for pioneering.

For a career in oceanography, university graduation with specialization in mathematics, physics, chemistry, or engineering is a good starting point. In addition to the foregoing, postgraduate training in oceanography is an essential requirement. Oceanographer trainees are given operational training at sea and ashore, and are assisted in obtaining postgraduate training by educational leave arrangements.

Hydrography is, in essence, the cartography of water, just as topography is the cartography of land. Where topography measures elevations, hydrography measures depths. Hydrographic charts are destined almost exclusively to be used as guides for maritime navigation. Because water is so much less stable than land, hydrographers must keep track of tides, currents, the presence of ice and its movement, the formation and erosion of sandbars, and water levels on inland waters. For the aid of ship captains, hydrographers place on their charts such data as compass variation and the position of lighthouses, buoys, and other artificial or natural landmarks. In addition to charts, hydrographers also produce books of sailing directions, tide tables, and water level bulletins.

Qualifications for professional hydrographers are similar to those of topographical and legal surveyors, with stress on knowledge of navigation.

To carry on its mapping and sea studies, the Marine Sciences Branch has, at this writing, seven ships, six large and four small launches, and two chartered vessels, all of which are looked after by the Branch's Ship Division. The largest and latest vessel especially built for Canadian marine studies, the 4,600-ton CSS *Hudson*, was launched in 1963.

Geological Survey of Canada

The Geological Survey of Canada is one of the oldest government agencies in the country; in fact, it antedates Confederation by some 25 years. During its century and a quarter of exploration the Geological Survey has accumulated a large store of knowledge about Canada's mineral resources and a proud tradition of research. Yet so vast is the territory to be surveyed that in many areas, notably in the north, the Survey has literally only begun to scratch the surface.

The Survey does not, of course, follow up promising mineral or metal occurrences with detailed exploration; this is left to the multitude of private development and mining companies. The Survey's job is to provide geological maps and basic information by which prospectors, exploration companies and others can chart their course.

This approach to geological exploration cannot, of course, be narrowly utilitarian, nor can it be abstract. Such studies as those of the Upper Mantle Project, palaeomagnetism, age determination with carbon-14, potassium-argon, rubidium-strontium and other isotopes may be considered "pure" research, but they will no doubt yield valuable practical information. On the other end of the scale are projects such as groundwater studies and investigations of dam and bridge sites which combine geology and engineering.

Every summer the Geological Survey sends into the field some 80 to 100 parties. Some of these parties continue the reconnaissance mapping (e.g., at four to eight miles to the inch) of Canadian regions, while others work at more detailed scales (one mile to the inch). Still others investigate specific occurrences in several different regions, an approach which is gaining in importance.

Administratively the scientists of the Geological Survey are organized into divisions according to the geological region in which they specialize — Appalachian, Canadian Shield, Cordilleran — and by function and professional training. In the latter group are divisions devoted to economic geology, petrological sciences, the study of fuels and stratigraphy, and geophysics. There is, of course, much interdisciplinary contact.

This division of labor means that some Geological Survey of Canada scientists may spend half their year in the field and the other half in the office; while others may work in the office or laboratory the year round.

Modern exploration methods have brought about great changes in geological surveying. Airborne transportation, by fixed-wing aircraft or helicopter, has become the standard in many areas, especially in the north. But geologists use aircraft not only for transportation, they also conduct a good deal of surveying with airborne instruments, such as magnetometers.

Pleistocene geologist examines cut in glacial-lake sediments in the Vernon area, B.C.

One of the most interesting new survey techniques is geochemistry and its derivative, biogeochemistry. Geologists working in these fields use the dilution of minute quantities of minerals in rivers, the soil, and vegetation to track down major deposits not discoverable by conventional means.

In the laboratory, the Geological Survey is making excellent use of the new analytical possibilities offered by age determinations of isotopes. Palaeomagnetism, seismicity, and other phenomena are studied by geologists to gain fundamental knowledge about the structure of the earth itself.

The Geological Survey of Canada maintains close contact with mining and development companies, with provincial agencies, and the interested public. It issues its findings chiefly in the form of maps and reports. The Survey also maintains offices in several of Canada's chief mineral areas (e.g., Calgary, Vancouver, Yellowknife, Whitehorse) to distribute information to miners and prospectors.

The highly specialized knowledge needed for geological mapping can normally be gained only through lengthy formal education. Even within the Department, the Geological Survey of Canada has a particularly high proportion of university graduates, and most major research positions are occupied by holders of doctorate degrees. Apart from this, of course, the Survey offers fascinating opportunities for postgraduate studies, each season yielding several master's and doctor's theses. Its interest in furthering geological studies is also shown, among other things, by its annual grants-in-aid to Canadian universities.

Dominion Observatories

The scientists of the Dominion Observatories Branch are concerned primarily with the study of the universe. Since the earth is, after all, a heavenly body with many of the same characteristics as other planets and stars, the Observatories Branch devotes a large portion of its research to terrestrial phenomena. Chief among these are geomagnetism, gravity, and seismicity.

Installations of the Observatories are spread all across Canada. Most important are the observatories at Ottawa, Victoria, and Penticton. Each of these is designed for a special type of astronomy: the Ottawa observatory specializes in positional astronomy, the Victoria observatory in star spectrography, and the Penticton establishment in radio-astrophysics. While Ottawa and Victoria use optical mirror telescopes, Penticton uses a wide-screen radio telescope, 84 feet in diameter, to catch faint electronic pulses emanating from such accumulations of matter as galactic hydrogen. To supplement such observations, Penticton also has a low-frequency telescope array laid out in the form of a T with a long crossbar measuring ¾ of a mile.

The results of such outer-space studies are manifold. Positional astronomy provides surveyors and navigators with lists of reference stars, and it also makes possible an extremely accurate time-keeping device operated in conjunction with an atomic clock which provides exact time for all of Canada. Knowledge about the physical composition of stars and meteors helps to make clearer the origin and structure of the earth, and studies of energy transmission in the universe yield vital information for space travel and exploration.

The Observatories' seismologists who study both natural and man-made earthquakes have set up a chain of seismograph stations with uniform distribution across Canada. The information collected is compiled on earthquake probability maps for the guidance of builders, insurance companies, and other interested agencies, and it also provides valuable clues to the structure of the earth's deep interior. Much progress has been made in the technology of seismographs, and instrumentation is being improved year by year.

The Gravity Division is working to complete gravity measurements for the land mass of Canada. Perhaps the most interesting gravity research is now being carried on at sea — on the surface, in submarines, and at the sea bottom. This includes measurements on the sea ice in the Arctic. Much remains to be done in instrumentation research for sea-gravity studies, a field in which ingenuity and technical competence promise high rewards.

The magnetic observatories of the Geomagnetism Division record the regular daily changes of the earth's magnetism as well as the erratic solar-induced changes

Bird's-eye view of T-shaped array of radio telescope in preparation at the Dominion Radio Astrophysical Observatory near Penticton, B.C. The observatory's 84-foot parabolic telescope and buildings are in right centre.

known as magnetic storms. Experimental work on the automation of these observatories is in progress. Instruments like the stabilized three-component airborne magnetometer and the proton-precession magnetometer have been developed by this division for geomagnetic mapping. Geomagnetic maps are used in mineral prospecting, navigation, and surveying.

A particularly interesting field for magnetic, seismological, and gravity studies are the ancient meteorite craters found on the Canadian Shield, with their obvious similarity to lunar features.

The work of the astronomer and the geophysicist is highly specialized, and demands a high degree of training. Graduation in physics or mathematics is a good starting point for a career in these fields.

Geographical Branch

The Department's geographers are concentrating their activities on certain definite areas of study. These are the exploration of Arctic terrain morphology, the mapping of land use in certain key industrial and agricultural areas of southern Canada, an inventory of ice formation and movement both in the Arctic Ocean and in certain more southerly waters such as the St. Lawrence River, glacier studies on Arctic islands, and the study of the origin and the standardization of geographical names in Canada. The Branch acts as the executive of the Canadian Permanent Committee on Geographical Names.

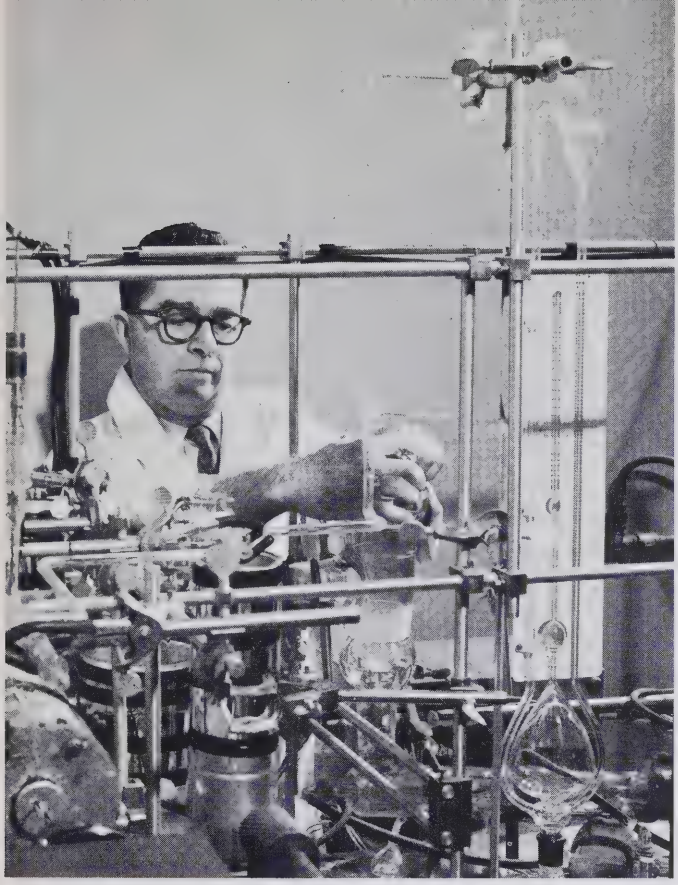
The Geographical Branch has also published and is keeping up to date the official *Atlas of Canada*, and maintains an active interest in international geography, both by collecting information on foreign countries and by taking part in the work of international geographical societies and conferences.

Although the permanent staff of the Geographical Branch is not large, it is supplemented each summer by university geographers who do a good deal of field work.

The land-use surveys of the Branch are valued as a guide for town planning, conservation measures, civil defence planning, and development of agriculture. The glaciological and terrain studies in the Arctic are yielding information about the climatic history of the region and are useful as a guide to northern development.

Graduation in geography is the logical requirement for a geographical career, although the work of the Geographical Branch touches on many sciences and provides opportunities for interdisciplinary studies.

A geographer makes notes of frost-fissured limestone on Melville Peninsula in the District of Franklin.



An unusual type of research, of great interest to the metallurgical industry, is the study of surface tension of molten metals. Here a technician determines surface tension of molten zinc in the Mines Branch laboratory.

(photo by George Hunter)

Mines Branch

The Mines Branch is, in effect, a giant laboratory complex in which all aspects of the extraction and the processing of mineral resources are studied and improved. "Mineral resources" in this context means the totality of non-biological wealth lying below the soil: water, gravel, clays, metal ores and pure metals, petroleum, gas, coal; and "extraction and processing" includes rock stresses in mines, milling and concentration of ores, leaching of gold and uranium, the smelting and alloying of metals, the study of metal corrosion and resistance to stress, refining of petroleum, the burning of coal, the production of ceramics — in short, an almost inexhaustible field.

The Branch is divided functionally into five research divisions, all located in Ottawa. Within the next decade the entire Branch is scheduled to move, stage by stage, to specially designed accommodation at the Ottawa suburb of Bell's Corners, where a 947-acre site has been acquired and is being developed.

The work done by the Branch can best be understood by taking each division separately.

The scientists of the Mineral Processing Division seek economical ways of processing metallic and non-metallic ores by improving present processing methods to make them less expensive or by developing new methods to meet special conditions. They use laboratory and pilot-plant tests on flotation, crushing, gravity concentration, and other methods of treatment. The division also works on the dressing and beneficiation of metallic and non-metallic minerals, and the processing and use of industrial minerals such as clay, construction materials, etc.

The Extraction Metallurgy Division helps industry to make efficient use of hydrometallurgical and pyrometallurgical processes in the extraction of metals from ores. It works closely with producers of uranium, gold, iron, and rare metals such as cesium and niobium, and tries to devise more efficient and economical ways of separating such contained metals from accompanying impurities by acid leaching, cyanidation, roasting, etc. Corrosion research is carried out on many kinds of metal manufactures. The division also does basic research on the interactions of metals and various chemicals in the solid, liquid, and gaseous states.

In the Mineral Sciences Division, the latest chemical and physical technology is brought to bear on the analysis of minerals. This work is pursued along four avenues: mineralogy, chemical and spectrochemical analysis, physics and radiotracer studies, and physical chemistry. By these methods the scientists of the division ascertain the quantities and qualities of metals and minerals composing samples of ores or manufactured products submitted by private and government agencies. They also develop analytical standards and methods, and instruments.

Better mining techniques, mine safety, more efficient refining of petroleum, and better use of coal are the chief objectives pursued by the Fuels and Mining Practice Division. The division's investigators test mining equipment and develop instruments and methods for ensuring mine safety. In petroleum research, pilot plants are operated for the development of more efficient refining techniques, or the refining of low-grade oils and oil-bearing sands. New ways are constantly being sought to improve, and encourage, the burning of Canadian coals.

Research in the Physical Metallurgy Division concentrates on the production of metals and alloys, and on their qualities and applications. In cooperation with private industry and national defence agencies, physical metallurgists are seeking new uses for uranium alloys, the reduction of metal fatigue, better welding techniques, corrosion control, and improvements in the manufacture and treatment of metals. The division receives a large number of samples each year for tests and recommendations.

In their investigations, Mines Branch scientists work with some of the most advanced space-age techniques and apparatus. Many of the testing instruments are designed and constructed in the Branch itself, and instrumentation research receives much support. An electron probe microanalyzer and a neutron generator for mineral analysis, rock stressmeters, a high-pressure catalytic cracking unit for refining research, radiometry assay equipment are among the apparatus recently acquired or constructed by the Mines Branch.

Explosives Division

The small Explosives Division is a self-contained agency whose job it is to ensure proper safety in the manufacture, sale, storage, importation, and highway transportation of explosives and fireworks.

The Division administers the Canada Explosives Act, and pursues its work along two lines: (1) by analyzing and acting upon the results of tests carried out by the Fuels and Mining Practice Division of the Mines Branch on newly introduced explosives; and (2) by inspecting explosives factories and warehouses. Division officers also investigate the causes of accidents and conduct a publicity campaign to point out the dangers of carelessness in the storage or highway transportation of explosives.

Mineral Resources Division

The work of the Mineral Resources Division, an autonomous unit within the Department, differs from that of the scientific research units. It concerns itself entirely with informational and administrative tasks in the field of mineral economics. To this end, the officers of the division collect and analyze a wealth of facts and figures gleaned from mining and oil companies in Canada and abroad, from statistics on national and international trade in natural resource commodities, from government policies concerning mineral production and trade, and from the findings of the Geological Survey of Canada and other public and private geological agencies in Canada and abroad. Such analyses and compilations are then made available to the mining industry through various publications and through correspondence.

Among the administrative tasks of the Mineral Resources Division are the regular inspection of Canadian gold mines in connection with subsidies paid under the Emergency Gold Mining Assistance Act, advice to the Department of National Revenue on taxation of mines, and participation in numerous government committees and study groups dealing with the evaluation, exploitation, and marketing of Canada's natural resources.

The division employs mineral economists, and mining, geological, or metallurgical engineers with an interest in economics and information work.

Polar Continental Shelf Project

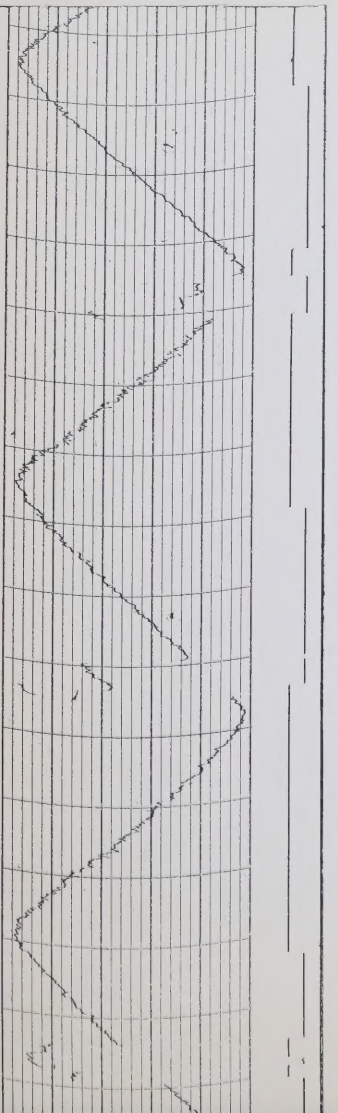
The Polar Continental Shelf Project was set up pursuant to a decision of the Federal Government in 1958 to "conduct surveys and scientific research in the continental shelf area of Arctic Canada." The decision to undertake this work stemmed from concern about the lack of scientific knowledge about the Canadian Arctic and growing awareness of the future importance of potential resources in our continental shelves.

Bedding down under the midnight sun in the Arctic. Scientists attached to the Polar Continental Shelf Project on Axel Heiberg Island cannot be choosy about campsite.

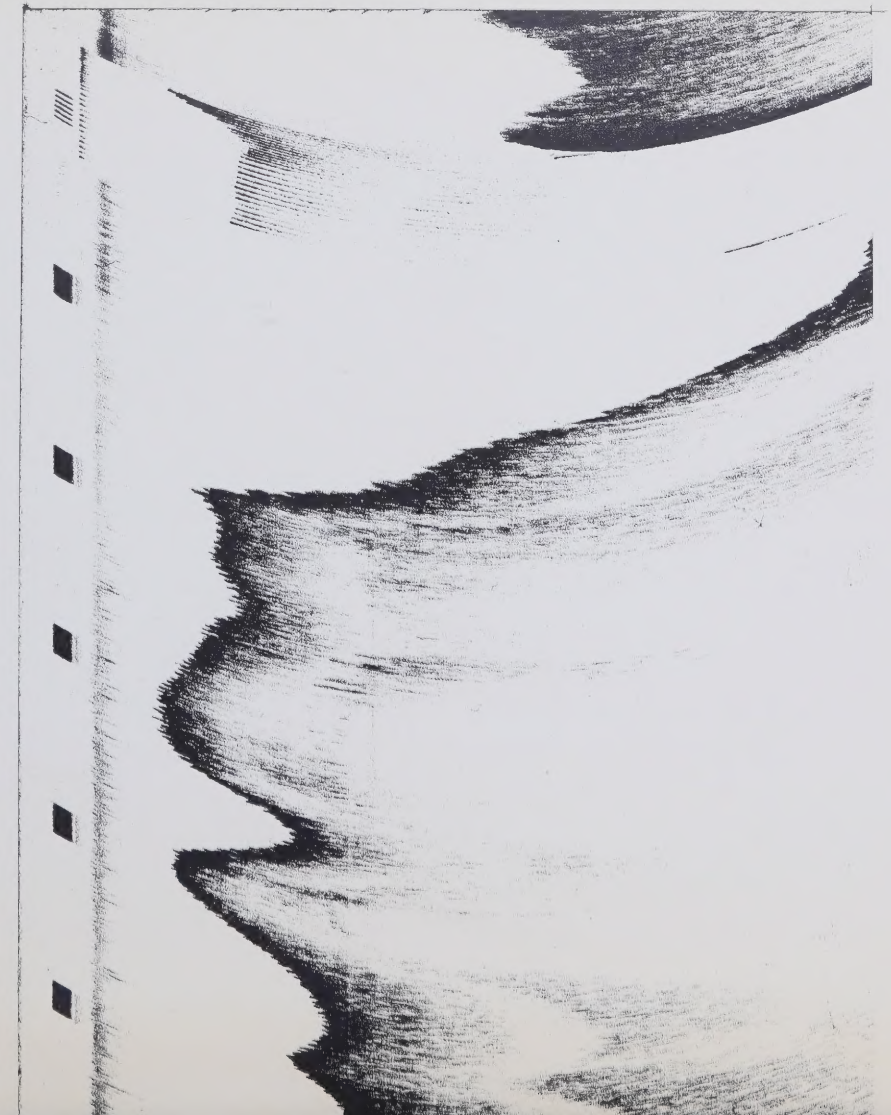
Beginning with the 1959 field season, scientists drawn from the Geological Survey, the Surveys and Mapping Branch, the Geographical Branch, the Marine Sciences Branch, and the Dominion Observatories have explored and mapped the waters, islands, and submarine features of the Queen Elizabeth Islands in a co-ordinated multi-discipline effort. The administrative setup of the Polar Continental Shelf Project differs from that of the Department's other units insofar as scientific personnel is concerned. Some of the scientists attached to the Project, or collaborating with it, remain employees of their respective Branches, whereas others are employed by the Project directly. There is a good deal of flexibility in such matters to meet changing requirements from season to season.

Although the activities of the Polar Continental Shelf Project are similar to those of the above mentioned Branches in other parts of Canada, the special conditions of the rugged Arctic environment have resulted in many modifications and adaptations in methodology and equipment. This applies, among other things, to depth-sounding techniques, sea-ice studies, studies of land forms in relation to glaciology, gravity measurements on ice, geomagnetism, and of course Arctic logistics, almost a science in itself. The Polar Continental Shelf Project thus offers to the men working on it an especially challenging and interesting career.

PORTION OF AERODIST
AERIAL SURVEY TRACING



ECHO SOUNDER GRAPH OF RIVER BOTTOM



EARTHQUAKE RECORD, ALERT, 19 MAY 1962